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| 10/766,599 | 01/27/2004 | Howard S. Taylor | 028080-0119 | 3408 |

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| EXAMINER | |
|---|---|
| SELLERS, DANIEL R | |
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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

| Office Action Summary | Application No. | Applicant(s) |
|---|---|---|
| | 10/766,599 | TAYLOR ET AL. |
| | Examiner | Art Unit |
| | Daniel R. Sellers | 2615 |

***-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --***

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on 25 June 2007.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-17 and 25-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17 and 25-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 27 January 2004 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Response to Arguments*

1. Applicant's arguments filed 6/25/07 have been fully considered but they are not persuasive.

2. Regarding claim 1, limitation A, Smith is directed to the same subject matter as shown by Smith, Col. 1, line 21 - Col. 2, line 41). Smith teaches "Pulsed NMR uses a burst of or pulse of energy that is designed to excite the nuclei of a particular nuclear species of **a sample** being measured (the protons, or the like, of such sample having first been precessed in an essentially static magnetic field); in other words the precession is modified by the pulse. After the application of the pulse there occurs a **free induction decay (FID)** of the magnetization associated with the excited nuclei." (Col. 1, lines 28-36). The applicant's specification, on page 1, paragraph 0005, states "In most experimental NMR studies, excessive noise can be present in the **measured time domain signal**, which decays exponentially and **is thus called an FID** ("free induction decay") signal." Furthermore, Smith teaches the collection of FIDs (Col. 3, lines 31-34 and Col. 5, lines 57-62). Then, "five to one hundred measurement cycles are conducted to obtain a usable measurement. Each of these... cycles involves a modulated transmission/reception/flash A-D conversion, and storage of data. The curves are then **averaged** for noise reduction before M-L curve fitting, M-L is applied and the above listed intercepts and ratios are established." (Col. 7, lines 46-52). Smith is teaching measuring a sample, collecting many FIDs, and averaging before using a curve fitting process. The curve fitting process is irrelevant with respect to the claimed

subject matter. As shown above, and with respect to the Claim Rejections under 35 USC 103, Smith teaches claim 1, part a.

Regarding limitation b), on page 17 of the remarks, it is referred to as limitation a), however these limitations are found in claim 1, limitation b). Smith teaches the `x` variables, which comprise a vector space and this is evident by the statement that these parameters "form a multidimensional model". These `x` variables are derived from the FID measurements, which were subsequently averaged. Smith teaches these limitations.

Regarding limitations b), d), f), and h), on page 18 of the remarks, Smith teaches eigenvalues (C), which come from a correlation matrix (XX') and satisfies equations 1-5 (Col. 9). The correlation matrix is calculated from the `x` variables (Col. 9, lines 10-18), which are derived from an averaged measurement of excitation pulses (Col. 7, lines 46-52). Furthermore, Smith teaches an ordered array of eigenvalues, i.e. sorted numerically largest to smallest (Col. 9, lines 45-47). Smith teaches re-analyzing the FID via the M-L when the gap has not appeared, i.e. the sample is not within 3 to 5 standard deviations, which is a measure of how far apart the smallest eigenvalue in the Z1 subset is from the normalized calibrated z (Col. 10, lines 49-54). The standard deviation is a measure of how closely grouped the elements of the Z1 susbset are, which are the z's that improve upon the accuracy of the "value". The smallest z in the Z1 subset is used, and when this value is within the threshold, it indicates that the Z1 subset is separate from the noise subspace, which is inherently contained within the larger set of z's. When the value is outside the threshold, this indicates that the Z1 subset still contains

very small eigenvalues, which are indicative of eigenvalues corresponding to noise. Therefore a gap is achieved when the smallest z in the Z1 subset is within 3 to 5 standard deviations. The system taught by Smith will ask for repeated measurements of a sample, when repeated failures occur (Col. 10, lines 16-19, 45-56, and Fig. 3). This reads on the performing additional measurements if a gap has not appeared, wherein the gap has appeared in the data when the preferred subset Z1 is within 3 to 5 standard deviations. Likewise, this reads on preventing further measurements, because when the gap has appeared the process taught by Smith goes on to "predict the desired property." (Col. 10, lines 55-56 and Fig. 3, step 72). Smith teaches a display (Col. 5, lines 53-56), however, Smith does not teach a displayed graph to illustrate when the gap has appeared. This is addressed in the following 35 USC 103 rejections.

3. Worley, presented in prior Office Actions, supports the association of small singular values, or eigenvalues, with a noise subspace and the large eigenvalues are associated with a noisefree subspace. Smith is teaching the same idea, but uses different terminology, wherein noise is associated with data that shows multicollinearity (Col. 9, lines 47-50).

4. Regarding the Official Notice with respect to claims 12 and 13, the applicant has not sufficiently traversed these statements. Therefore, these statements are now considered an admission of prior art.

### *Claim Rejections - 35 USC § 103*

5. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

6. **Claims 1-4, 6, 14-17, and 25-28** are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith, USPN 5,420,508 in view of Konno et al., USPN 5,148,379 (hereinafter Smith and Konno, respectively).

7. Regarding **claim 1**, see Smith

*An apparatus for performing spectral analysis of a sample* (Fig. 1 and Fig. 3, step 60), *the apparatus comprising:*
*a. a data acquisition system configured to measure a signal emitted from the sample in response to excitation energy applied thereto* (Col. 5, lines 37-63; and Fig. 1, units 104-3, 105-1, 105-3, and 106), *and to average the measured signal over a plurality of measurements to generate an averaged signal for the sample* (Col. 7, lines 46-52);

*b. a data processing system including:*
*a noise-reduction pre-processor configured to create a vector space from said averaged signal* (Col. 7, line 66 - Col. 8, line 9), *and to generate one or more singular values and corresponding eigenvectors of a correlation matrix constructed within said vector space, said vector space containing a noisefree signal subspace and a noise subspace, said singular values including noisefree singular values associated with said noisefree signal subspace, and noise singular values associated with said noise subspace* (Col. 8, line 60 - Col. 9, line 56; and Fig. 3, steps 60, 62, and 64); *and*

*c. a control system configured to identify, <u>in a graph of the singular values of the correlation matrix constructed within the vector space created from the averaged signal</u>, a gap between a smallest noisefree singular value and a first noise singular value, so as to request the data acquisition system to perform additional measurements of the signal emitted from the sample if no such separation gap can be identified, and to prevent further measurements of the signal emitted from the sample from being made by the data acquisition system if the gap has appeared and is stable.* (Col. 9, line 45 - Col. 10, line 20; Col. 10, lines 28-63; Col. 4, lines 34-45; and Fig. 3, steps 60, 66, 68, 70, and 72).

Smith teaches an NMR spectral analysis with these features. Smith teaches that the smallest singular values correspond to noise and cause the statistical fitting procedure (the M-L fit) to produce an erroneous result (Col. 2, line 42 - Col. 3, line 28; and Col. 3, line 59 - Col. 4, line 27). The control system reduces the amount of noise singular values in the Z1 subset (Col. 10, lines 36-54, or steps (4)-(11)), which has the same

effect as identifying the gap between the smallest noisefree singular value, or the smallest signal eigenvalue, and the noise singular value, or the noise eigenvalue. Smith teaches that the control system performs additional measurements when the gap is not defined, or the statistical fit provides erroneous errors, and prevents further measurements when the gap is stable (i.e. the M-L fit, or statistical fit, provides plausible results as a result of accepting the Eigenvectors that fall within 3, 5, or 7 standard deviations from the mean, or dropping the noise associated singular values from calculations) (Col. 10, lines 4-20; Col. 10, lines 36-44, or steps (4)-(6); and Fig. 3, steps 60, 62, 64, 66, 68, and 70). It is inherent that eigenvectors, and their associated eigenvalues, or singular values, are very large or very small when they fall outside 3, 5, or 7 standard deviations from an expected, or mean, value. Smith teaches the features of a display, the pattern recognition system, and the command signal generator. However, Smith does not teach that the graphics system generates a plot of the singular values.

Konno teaches the display of eigenvalues, or singular values, for verification (Col. 25, lines 12-17; and Fig. 30). It would have been obvious for one of ordinary skill in the art at the time of the invention to combine the teachings of Smith and Konno for the purpose of verifying the accuracy of the system (Col. 4, line 33 - Col. 5, line 20) and aiding in the visualization of scientific data.

8. Regarding **claim 2**, the further limitation of claim 1, see the preceding argument with respect to claim 1. Smith teaches an NMR spectral analysis using RF excitation pulses, wherein an NMR transient, or free induction decay (FID), is measured.

9. Regarding **claim 3**, the further limitation of claim 1, see Smith

*3. An apparatus in accordance with claim 1, wherein said control system comprises:*

*a. a graphics system adapted to generate the plot of said singular values* (Col. 5, lines 52-55 and Fig. 1, unit 110)*;*

*b. a pattern recognition system adapted to identify the gap in said plot between said smallest noisefree singular value and said adjacent noise singular value, and to verify the stability of said gap* (Col. 9, line 45 - Col. 10, line 24; and Fig. 3, step 70)*; and*

*c. a command signal generator, responsive to said pattern recognition system, configured to generate an output signal requesting for more measurements from said data acquisition system, in the absence of an identifiable gap, and to generate an output signal requesting that further measurements be discontinued, if the appearance and the stability of said gap has been established by said pattern recognition system* (Col. 10, lines 28-63; Col. 4, lines 34-45; and Fig. 3, steps 60, 66, 68, 70, and 72).

Smith teaches the features of a display, the pattern recognition system, and the command signal generator. However, Smith does not teach that the graphics system generates a plot of the singular values. Konno teaches the display of eigenvalues, or singular values, for verification (Col. 25, lines 12-17; and Fig. 30).

10. Regarding **claim 4**, the further limitation of claim 1, see Smith

*wherein said noise-reduction preprocessor comprises:*

*a. a matrix generator configured to form the vector space from the averaged signal and constructing the correlation matrix within the vector space, the vector space containing the noisefree signal subspace and the noise subspace* (Col. 7, line 46 - Col. 8, line 9; and Col. 8, lines 41-49)*;*

*b. a matrix diagonalizer configured to diagonalize the correlation matrix to obtain its singular values and the corresponding eigenvectors, the singular values including noisefree singular values associated with the noisefree signal subspace, and noise singular values associated with the noise subspace* (Col. 8, line 60 - Col. 9, line 56; and Col. 10, lines 30-56)*; and*

*c. a signal projector configured to project the averaged signal onto the noisefree subspace to generate a noise-reduced signal* (Col. 9, lines 57-65).

Smith teaches noise-reduction preprocessor with these features. Smith constructs a vector space from averaged signals (Col. 7, lines 46-61), and constructs a correlation matrix within the vector space (Col. 9, lines 13-19), wherein it is known that this vector space contains a noisefree signal subspace and a noise subspace (Worley teaches that an Eignenspace of the correlation matrix can be partitioned into a noisefree subspace

and noise subspace, p. 2130, paragraph 3). Smith uses principal component analysis, which reads on a matrix diagonalizer.

11. Regarding **claim 6**, the further limitation of claim 1, see the preceding argument with respect to claim 1.

*... wherein said data acquisition system is configured to sample each measured signal with a sampling period τ, and to average the corresponding sample points over said plurality of measurements, so as to store said averaged signal as a discretized set of N data points* $C_n$ (n = 0 .... , N-l). (Col. 7, lines 17-61).

Smith teaches an apparatus with these features.

12. Regarding **claim 14**, see the preceding argument with respect to claim 1. Smith teaches these features.

13. Regarding **claim 15**, see the preceding argument with respect to claim 1. Smith teaches these features.

14. Regarding **claim 16**, see the preceding argument with respect to claims 1, 3, and 4. The combination of Smith and Konno teaches these features.

15. Regarding **claim 17**, see the preceding argument with respect to claim 1. Smith teaches these features.

16. Regarding **claim 25**, see the preceding argument with respect to claims 1 and 4. Smith teaches these features.

17. Regarding **claim 26**, see the preceding argument with respect to claims 1 and 4. Smith teaches these features.

18. Regarding **claim 27**, see the preceding argument with respect to claim 1. Smith teaches these features.

19. Regarding **claim 28**, see the preceding argument with respect to claim 1. Smith teaches these features.

20. **Claims 5, 7, and 8** are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith and Konno as applied to claim 4 above, and further in view of Freeman, USPN 3,752,081.

21. Regarding **claim 5**, the further limitation of claim 4, Smith teaches the features of claim 4. Smith alludes to frequency-domain transformations (Col. 5, lines 9-12), but does not teach the generation of a spectrum by converting the noise-reduced signal into a frequency-domain. Freeman teaches this feature (Col. 5, lines 27-54). It is inherent that the noise-free component is used to create the desired spectral plot. It would have been obvious for one of ordinary skill in the art at the time of the invention to combine the teachings of Smith, Konno, and Freeman for the purpose of generating a spectrum to be displayed later as a spectral plot.

22. Regarding **claim 7**, the further limitation of claim 6, Smith teaches the features of claim 6, wherein it is inherent that the system is configured to store each data point as a noisefree component and a noise component. This is inherent because Smith separates the data into these two sets. In the combination, Freeman teaches the step of converting the input data into frequency components for a spectral analysis, wherein it is inherent that the data processing system needs to store the finite sum of damped complex harmonics weighted by respective coefficients, or frequency components.

23. Regarding **claim 8**, the further limitation of claim 7, see the preceding argument with respect to claim 7. Freeman teaches a Fourier transform, wherein the components are described by the claimed mathematical function.

24. **Claims 9-13** are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith and Konno as applied to claim 1 above, and further in view of Meyer et al., USPN 5,485,086 (hereinafter Meyer).

25. Regarding **claim 9**, the further limitation of claim 1, see the preceding argument with respect to claim 1. Smith and Konno teach the features of claim 1, however they do not teach a windowing subsystem. Meyer teaches a windowing system configured to apply a windowing filter to a Fourier transform, which inherently generates a decimated signal having a limited bandwidth (Col. 3, line 30 - Col. 4, line 4). This temporal filtering can be done after averaging the acquired signals or after singular value analysis, and it would be obvious to employ either of these methods. It would have been obvious for one of ordinary skill in the art at the time of the invention to combine the teachings of Smith, Konno, and Meyer for the purpose reducing image artifacts caused by movement of the sample.

26. Regarding **claim 10**, the further limitation of claim 9, see the preceding argument with respect to claim 9. It is inherent in the combination that the decimated signals are converted back into the time domain and stored as a set of decimated points. It is also inherent that the resulting signal has a signal length smaller than the original.

27. Regarding **claim 11**, the further limitation of claim 10, see the preceding argument with respect to claim 1. Smith teaches the feature of creating a vector space, which has M dimensions. The N-M+1 linearly independent vectors are represented by the largest eigenvectors, wherein Smith, Konno, and Meyer teach the decimation of the data. It would have been obvious to decimate the data before performing the principal components analysis as stated previously.

28. Regarding **claim 12**, the further limitation of claim 11, see the preceding argument with respect to claim 1. Smith teaches a correlation matrix of real valued signals. By definition, it is an inherent feature of a correlation matrix of real valued signals to be Hermitian, and since it is formed from principal components analysis and contains only positive eigenvalues, the matrix is covariant. The mathematical equation is a well-known equation for determining a correlation matrix, and applicant admits that this equation is used to acquire the correlation matrix.

29. Regarding **claim 13**, the further limitation of claim 11, see the preceding argument with respect to claim 11. Smith teaches a system analyzer that uses singular value decomposition techniques. The system as taught by Smith, inherently includes a method of projecting a signal onto eigenvectors. The applicant admits that this general equation is used for projection and well known.

## *Conclusion*

30. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

31. Manolakis, Dimitris G., Ingle, Vinjay K., and Kogon, Stephen M., "Statistical and Adaptive Signal Processing", Sections 3.5.1 - 3.5.3 (pp. 125-133) teaches the Karhunen-Loève transform for continuous signals and the discrete Karhunen-Loève transform (DKLT) for discrete signals. The DKLT is also known as the Hotelling transform (p. 130).

32. Gonzalez, Rafael C. and Woods, Richard E., "Digital Image Processing", pp. 677-679, teaches the Hotelling transform, which is also known as the principal components transform (p. 679).

33. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daniel R. Sellers whose telephone number is 571-272-7528. The examiner can normally be reached on Monday to Friday, 9am to 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sinh Tran can be reached on (571)272-7564. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

SINH TRAN
SUPERVISORY PATENT EXAMINER

DRS